



## Tomorrow's Energy Today

for Cities and Counties

Hurricane Andrew left hundreds of thousands of victims homeless in southern Florida. Typical of the damage wrought were the remains of this mobile home at the Everglades Labor Camp.

# When Disaster Strikes, the Sun Can Still Shine Through

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*Solar-powered energy sources add a new dimension to local governments' disaster relief plans.*

On August 24, 1992, Hurricane Andrew raged over southern Florida, demolishing much of south Dade County. Southern Florida hasn't been the same since.

Cutting a path of incredible destruction, Andrew left more than 1.4 million homes and businesses without electricity. Hundreds of thousands of victims were left homeless, most traffic lights were knocked out, and food, untainted water, and medical supplies were desperately needed. Total damage was estimated at more than \$30 billion.

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### *Innovative Twist to Disaster Relief*

Immediately after the hurricane, backup emergency power was critically needed in two areas: communications and medical relief. According to Bill Young, Research Engineer at Florida Solar Energy Center (FSEC), "When power lines are down, citizens cannot be promptly informed of hazards, and it's difficult to notify emergency workers of situations that require their prompt attention. Electrical power is also crucial to medical clinics, which must operate such electronic equipment as vaccine refrigerators, other medical equipment, and emergency lighting."

Local government, emergency management teams, the military, and many other public and private groups began a massive relief effort. J.J. Brown, Division Chief for Policy and Planning with Metro-Dade Fire Rescue, says in hindsight that "The circumstances were desperate. We needed power for just about anything you could name. It was that bad."



Robin Flynn, Florida Solar Energy Center

*Photovoltaic (PV) arrays can offer immediate relief as well as longer term help in times of disaster.*

*PV-powered vaccine refrigeration at medical clinics eliminated the need to find dry ice daily to keep vaccines fresh overnight. Dr. Jonathan Schwartz, a volunteer resident physician from Jackson Memorial Hospital in Miami, provided medical care at Project First Base, a relief shelter in Homestead, Florida.*

In an innovative approach to the crisis, staff members of the University of Miami School of Medicine realized that photovoltaic (PV) systems could provide electricity for health care needs. They contacted FSEC and the Photovoltaic Design Assistance Center at the U.S. Department of Energy's Sandia National Laboratories in Albuquerque, New Mexico.

Ten days after the University of Miami's request for help, Sandia and FSEC delivered PV systems to the site, providing much-needed relief in the hardest hit areas. With financial assistance from the U.S. Department of Energy through Sandia, FSEC staff members configured five self-contained PV systems. These systems consisted of a 1-kilowatt PV array, batteries, a dc-to-ac inverter, a 50-amp battery charger, and end-use appliances, such as fluorescent lights, fans, and a vaccine refrigerator.

### *How the PV Systems Were Used*

Solar-generated electricity was soon powering four relief shelters and medical clinics. FSEC staff installed PV-powered street lights at the shelters and clinics, and interior lights, fans, and vaccine refrigerators at medical clinics. Through a demonstration project with FSEC, the Florida Department of Transportation deployed two trailer-mounted, PV-powered communications systems and eventually a PV-powered traffic signal.

Once set up, the PV systems provided power immediately. According to a city official of Homestead, the site of one relief shelter, Project First Base, "The PV systems were very useful. We would have needed to obtain regular generators to provide power for lights, and to set up poles and string up wires. Using PV-powered lights was much faster."

"The PV street and area lights were immediately available, and no other infrastructure was required. That kind of speed was essential at the time. City Hall served as command center for our emergency relief efforts, so the outside lights were very helpful for security reasons. At that time, we were still working 24 hours a day and were able to feel more comfortable with the lights."

Should other cities and counties consider using PV systems in disaster relief? In reviewing Homestead's experience, the answer appears to be yes. Many cities and counties need better emergency plans than those currently used. According to many emergency planning officials, it's important to look beyond the initial costs of such equipment and consider the intangibles offered—they're quiet, nonpolluting, and good for the environment.



Robin Flynn, Florida Solar Energy Center

## What's So Great about Photovoltaic Systems?

Photovoltaic (PV) systems offered numerous benefits during the relief efforts. As an alternate source of power, the use of PV systems allowed shelters to reduce the use of traditional gas generators.

For example, PV arrays allowed Homestead's medical clinic to cut its generator use by about one-half. And, at St. Anne's Catholic Mission, another medical clinic, generator needs decreased from three to one generator once the PV array was up and running. At yet another site, the South Dade Labor Camp, a generator was not required at all.

PV systems are:

Environmentally benign. Because they require no fuel, PV systems are cleaner and less expensive to operate than are gas or diesel generators. PV arrays don't contribute to pollution.

Quiet. Quiet systems may not sound like much of a benefit, but generators are noisy. And that noise is compounded when a generator is running around the clock under stressful, fatiguing conditions. PV arrays do their job silently. In fact, at the shelter at St. Anne's, mission workers had quit using their generators at night because of the noise and fuel shortages. When generators were running, nurses couldn't even hear their patients' heartbeats through stethoscopes.

Able to keep vaccines fresh. Once PV equipment was installed, volunteers no longer needed to worry daily about finding dry ice to keep vaccines fresh overnight.

Modular. "Modularity is the ability to increase or decrease energy output," explains Scott Sklar, Executive Director, Solar Energy Industry Association. "You can easily add more panels to a PV system to increase the output, but it's much tougher to increase output with a diesel generator. In a disaster situation, this kind of flexibility is critical."

Self-sustaining. "Because no fuel is required, you don't have to leave every few days to bring back fuel, or use mobile units to bring fuel in, the way you would with traditional generators," says Sklar. And Young from FSEC adds, "That's really important when you have no electricity and you can't get gas for a generator at the pump, because the pump is electrically driven, which is exactly what happened in some areas."

Safe. The emergency call load more than doubled at the Metro-Dade Fire Rescue headquarters after the storm. According to Brown, "Generators were causing all kinds of accidents. We had houses burn down because of improper generator use, and people were doing things like trying to fill generators while they were still running." "Not only that, but gas generators get hot when they're used 24 hours a day," Young adds, "and they can catch fire and explode, wounding people." PV systems don't involve these dangers.

Odorless. In close quarters, under hot, muggy, stressful conditions, the smell from generators' fumes can become overwhelming, say volunteers and emergency staff.

"The important thing is to do this planning up front," says Jim Dunlop, Senior Research Engineer, FSEC. "You don't want to wait until disaster strikes to try to obtain PV equipment. PV equipment is available, but it's not always in stock, so early procurement is critical. The next step is to do some simple design work; check to see if PV equipment already exists that will meet your needs."

A decision-making resource that local government officials can purchase is the *Photovoltaic Products and Manufacturers Directory*. This directory, published by FSEC, lists manufacturers of prepackaged PV systems and components (prepackaged systems are designed for a specific end use and require little or no assembly). Another helpful publication is *Photovoltaics for Municipal Planners*, available from the National Renewable Energy Laboratory (see *For More Information* on p. 6).

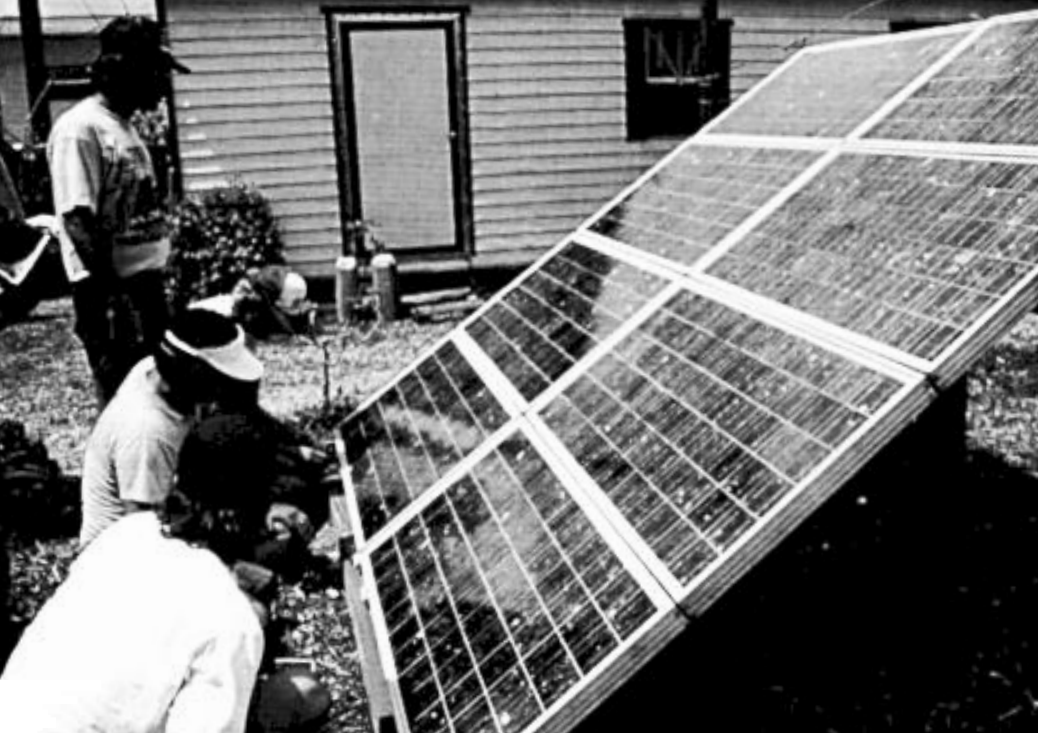
If your local government is not interested in purchasing or can't afford PV equipment, you may be able to borrow it. That's what Dade County did. "Our county's emergency management consists mostly of volunteers," explains Young. "We maintain a list of businesses, agencies, and individuals willing to donate their services, time, and equipment, including PV systems. When disaster strikes, we call. The equipment is not given to the county, but simply donated during the emergency."

And local governments might consider pooling their resources—with other local governments and other states in the region. If cities and counties have mandatory civil defense guidelines, they might wish to consider having PV units in their own inventory or establishing contacts that can allocate these resources when needed.

## Setting Up a PV Disaster Relief System

Because applying PV systems to disaster relief is still so new, there isn't a manual for cities and counties to follow. But there are some general guidelines. First, city and county officials need to identify the appropriate applications for using PV in their disaster aid plans. Applications will vary by locale—what's needed in the Midwest may be drastically different from what's needed in the Northwest.





Robin Flynn, Florida Solar Energy Center

A crew from the Florida Solar Energy Center completed the installation of a PV array at Project First Base, Homestead, Florida.

*The Hurricane Andrew experience proves the suitability of PV systems in disaster relief.*

Training emergency staff and volunteers how to run PV equipment and having simple written instructions available are also important. "Nobody had time to read the simple documentation we had prepared for the systems," says Dunlop. "So, to aid in the successful operation and understanding of the systems, we developed clear labels and large poster-board instructions that described the basic operation of the systems."

### *PV Applications for Your City or County*

Whether you are planning for disaster relief or exploring environmentally favorable energy sources, PV arrays offer immediate relief, long-term assistance, and a clean, renewable energy option for your city or county.

When disaster strikes, PV arrays can provide immediate relief as well as longer term help. Immediate uses include traffic control signals; area, street, and shelter/clinic lighting; and portable AM radio repeaters for response team communications.

For example, Florida's Department of Transportation used PV-powered radio systems for traffic control. Together with PV-powered changeable message signs, workers could direct drivers to relief shelters and provide critical information about traffic. Volunteer ham radio operators also used solar power to support emergency communications stations. Longer term uses for PV systems include power for medical clinics to provide vaccine refrigeration, lighting, fans, and other electrical equipment; rechargeable lanterns, radios, televisions, and other direct-current appliances; and small PV systems for homes without electricity.

The PV systems installed during the Hurricane Andrew relief effort were employed successfully for more than 2 months until conventional power was restored. One PV system operated a medical clinic for more than 9 months after the hurricane.

Extended use of PV systems benefits the environment by providing a renewable energy source that emits no greenhouse gases. Permanent installation of PV is a clean alternative that does not contribute to global climate change.

The Hurricane Andrew experience proves the suitability of PV systems in disaster relief. There's definitely a place for PV power in your city's or county's disaster relief or energy plans. ■

## Photovoltaic Systems

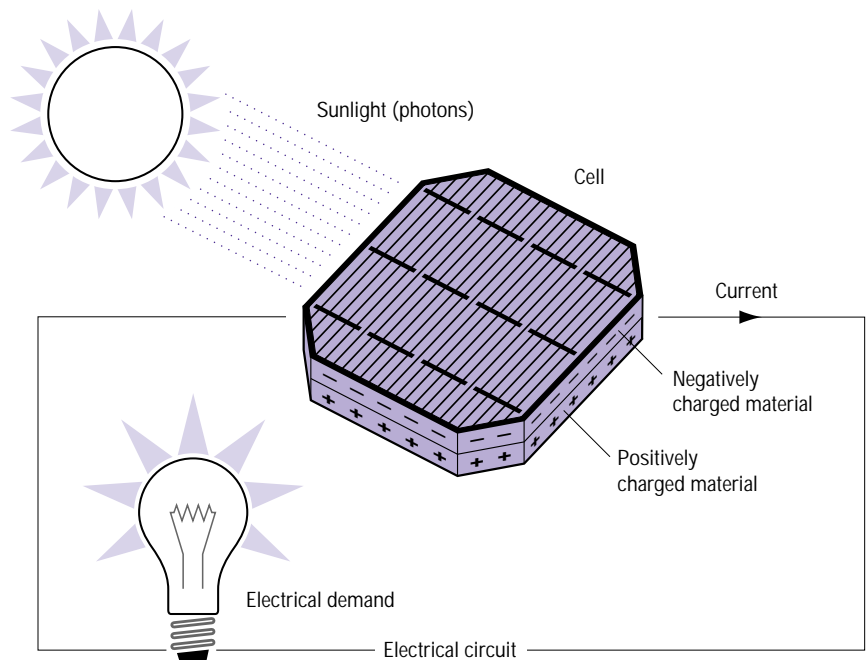
Photovoltaics (PV) is the conversion of sunlight to electricity by devices such as solar cells. Photovoltaic devices can be made from many different materials in many different designs. The diversity of PV materials and their different characteristics and potentials demonstrate the richness of this growing technology. Although many PV materials are available, single-crystal silicon is presently the most popular material. Usually, PV cells are made in wafer-thin circles or rectangles. Typically, they are 3 to 4 inches wide.

When photons of sunlight strike the surface of solar cells, the photons free electrons from the silicon's atoms. This is known as the photovoltaic effect. When specific chemicals are added to the cells, the chemicals help establish an electrical field for the released electrons to follow. An electrical current is then established. On average, a 4-inch solar cell produces 1 watt of direct-current (dc) electricity when exposed to sunlight.

A silicon PV cell is made by melting polysilicon and then reforming it into a solid, single-crystal cylinder. Sheer slices are cut from the cylinder, or ingot, and chemically treated to form the PV cells. Wires are then attached to the cell's negative and positive terminals to complete an electrical circuit. Several PV cells are wired together and laminated in a thin, protective glass case to complete a module. These modules can then be wired together to form PV arrays. The amount of electricity produced by an array depends on the number of modules it contains.

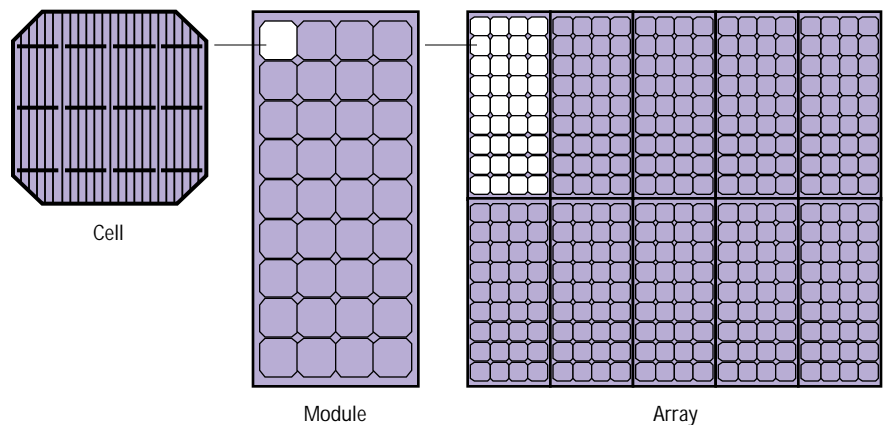
To power electrical appliances and equipment with PV arrays, a few other components are generally required. Batteries are used to store energy from the PV array to meet electrical demands when the sun is not shining. An inverter is sometimes used to convert dc battery voltage to alternating current (ac) to power common household appliances. Otherwise, dc appliances may be operated directly from the battery bank.

### Photovoltaic Cell Converts Sunlight Directly to Electricity



Source: Florida Solar Energy Center

### Photovoltaic Cell, Module, and Array



Source: National Renewable Energy Laboratory

## *For More Information*

### **Jim Dunlop or Bill Young**

Florida Solar Energy Center  
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Coco, FL 32922  
(407) 638-1000  
*U.S. Photovoltaic Products and  
Manufacturers Directory*

### **John Thornton**

National Renewable Energy Laboratory  
1617 Cole Boulevard  
Golden, CO 80401  
(303) 275-3000  
*Photovoltaics for Municipal Planners—  
document no. NREL/TP-411-5450-CC.*  
To order a copy of this publication, call  
NREL's Document Distribution Service at  
(303) 275-4363.

### **Beth Richards**

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### **Scott Sklar**

Solar Energy Industries Association  
122 C Street, 4th floor, NW  
Washington, DC 20001  
(202) 383-2600  
SEIA can provide additional information on PV  
technology and manufacturers.

### **Energy Efficiency and Renewable Energy Clearinghouse**

P.O. Box 3048  
Merrifield, VA 22116  
(800) 363-3732  
EREC, funded by the U.S. Department of  
Energy, provides information on renewable  
energy and energy efficiency technologies.

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*This document was produced for the U.S. Department of Energy (DOE) by the National Renewable Energy Laboratory, a DOE national laboratory. The document was produced by the Technical Information Program, under the DOE Office of Energy Efficiency and Renewable Energy.*

DOE/GO-10096-341  
DE97000069  
Revised November 1996



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